REPORT No. 79-6

#6
Sept 1979

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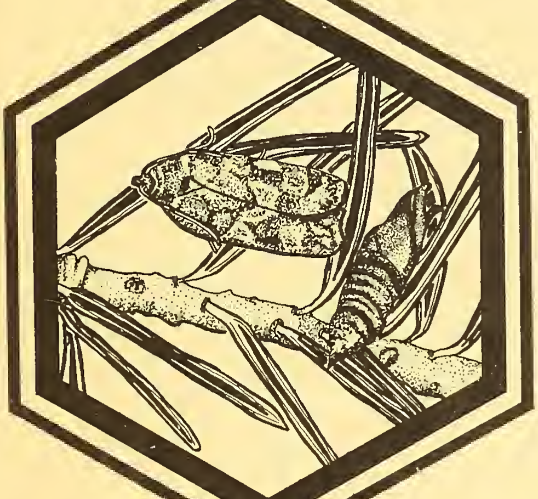

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Figure 1. Western hemlock residuals infected with dwarf mistletoe, a potential source of infection for the reproduction.

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DWARF MISTLETOE IN WESTERN HEMLOCK IN SOUTHEASTERN ALASKA

By

David B. Drummond and Frank G. Hawksworth[1]

ABSTRACT

Western hemlock infected with dwarf mistletoe was observed in old growth as well as in stands of mixed hemlock and spruce regeneration of various ages in southeast Alaska during late May 1979. Recent research on hemlock dwarf mistletoe in southeast Alaska and observations made during this visit suggest that earlier recommendations aimed at minimizing adverse effects of this mistletoe, based on pathogen spread and intensification in British Columbia (Vancouver Island), Washington, and Oregon, may not be appropriate in Alaska. The parasite seems to be intensifying in young stands at much lower rates in Alaska. Past observations are discussed, and recommendations considering the more recent information are presented.

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INTRODUCTION

In response to a request by the Alaska Region (R-10) Forest Insect and Disease Management (FI&DM) and the Pacific Northwest Forest and Range Experiment Station (PNW) Forestry Sciences Laboratory in Juneau, the authors visited hemlock stands in southeast Alaska infested by hemlock dwarf mistletoe, <u>Arceuthobium tsugense</u> (Rosendahl) G.N. Jones, to review current pest management practices. This visit occurred during the last two weeks of May 1979 (for Itinerary and List of Participants see Appendices I and II respectively).

Data dealing with host-parasite relationships and disease distribution throughout southeast Alaska's old growth and cutover stands is severely lacking. Initial work by the Forestry Sciences Laboratory during the last two years suggests that reevaluation of the effects of dwarf mistletoe in southeast Alaska, especially in cutover stands, is needed. The authors were invited to participate in this reevaluation.

OBSERVATIONS

The Alaska Region's current policy regarding dwarf mistletoe in hemlock is summarized briefly as follows[2]:

1. Pre-sale Examinations.

A. Identify evidence of mistletoe through stand examination and sale reconnaissance. Requests for specific surveys may be made from FI&DM. This information may be used to prepare project plans to be funded from either Knudsen-Vanderbilt (K-V) or FI&DM funds.

B. Record all information on mistletoe intensity or control needs in the appropriate compartment/stand file.

2. Mistletoe Control

A. For stands to be harvested as well as those harvested within the past five years where mistletoe is present, remove all residual hemlock from the harvested area. To the extent feasible, harvest dwarf mistletoe-infested residuals from uncut borders.

B. For stands that are between five and 20 years old that are not scheduled for other Timber Management treatment for at least five years residual hemlock should be removed if they are infested, and if intensive management is planned for the area.

C. For stands that are between five and 20 years old that are scheduled for pre-commercial thinning or hand release within the next

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2 Regional Forester's 3400 file memo on Cooperative Forest Insect and Disease Control, dated November 16, 1978.

five years dwarf mistletoe control should be scheduled as part of the work to be done at the next entry.

Region 10's management policy with regard to dwarf mistletoe was derived primarily from unpublished reports by Graham (1966), Shea and Stewart (1970), and Miller (1971). These reports summarized brief visits to southeast Alaska by the authors. A summary of their reports and other literature was compiled for the Region by Chew (1976). The pathologists visiting Alaska in the past were familiar with rapid rates of spread and intensification of hemlock mistletoe in the Pacific Northwest and on Vancouver Island, British Columbia (Smith 1977, Stewart 1976). Based on this knowledge and Alaska's proximity to the Pacific Northwest, they assumed that the pathogen would behave similarly in southeast Alaska.

Essentially all literature on the hemlock dwarf mistletoe biology and the effect the parasite has on hosts originated from outside Alaska (Laurent 1974, Russell 1976, Shaw 1978, Shea 1966, Shea and Stewart 1972). At the time of the Graham (1966), Miller (1971), and Shea and Stewart (1970) visits, relatively few stands of young growth hemlock were present, and it was prudent to utilize information on this mistletoe from other sources. Most clearcutting occurred from the 1960's on, so the young stands are generally less than 25 years old. There are now thousands of acres of young hemlock stands in southeast Alaska available for observation.

One of Shea and Stewart's (1970) recommendations was that a research pathologist be hired through PNW and stationed permanently at the Forestry Sciences Laboratory in Juneau. This was accomplished in 1977, and through his endeavors some unexpected differences are being documented in both the intensification and rate of spread of hemlock dwarf mistletoe. Many of the recent clearcuts (less than 10-15 years old) do not appear to be experiencing spread and intensification of dwarf mistletoe to the extent one would expect, based on the literature dealing with this disease-causing organism and its host.

Disease incidence was prevalent in the older stands that were visited. The age of these stands precludes any evaluation of rate of spread of the pathogen, and the increase in intensity of disease. Most stands are 250-300 years old, or older. The pathogen, even at reduced rates of spread, would still have sufficient time to reach the high intensities observed. When regenerated stands between the age of 10 and 15 were encountered with infected residuals present, very few infections were observed in the reproduction.

Studies by Dr. C.G. Shaw (Forestry Sciences Laboratory, Juneau) suggest that infection levels in young stands in southeast Alaska are substantially below those reported by Stewart (1976) for Oregon and Washington, and by Smith (1977) for Vancouver Island, B.C.. Stewart (1976) examined 39 stands with the following results:

Stand Age	Trees infected within 30 feet of infected residual trees. Average and range
Years	Percent
10-12	6 (1-23)
15	18 (8-75)
18-20	39 (8-91)
25	71 (28-77)

Shaw's preliminary results[3] for southeast Alaska show an average of less than 20 percent infection in 19-, 35-, and even 44-year-old stands.

The reasons for the apparently slower rate of mistletoe intensification in young stands in southeast Alaska are not yet known. It is possible that one or more of the following factors may be involved:

1. Pollination in this area may be unique, such that pollen dispersal is severely disrupted in cutover stands, and relatively few flowers become fertilized.

2. Dwarf mistletoe in these stands may have an unusually long incubation period compared with the typical five-year cycle in southern British Columbia (Smith 1971).

3. Extremely high rates of precipitation (100-200+ inches) may wash many seeds from the hemlock twigs before infection can take place.

4. The current low rate of intensification is possibly due to combinations of climatic and other variables which may not be typical in later years. These factors, and possibly others, may be acting in concert or independently to limit dwarf mistletoe development in young hemlock stands.

Studies are underway that should help delineate the rate of infection, spread, and intensification of the pathogen in the hemlock of southeast Alaska. Recommendations for research to pursue specific areas of study to help explain some of the differences observed are included in this report.

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3 Personal communication June 1979. Data for both studies were collected in areas adjacent to infected residuals and do not represent stand averages.

NEEDS

Much information concerning dwarf mistletoe on hemlock in southeast Alaska remains to be gathered. The observed differences suggest that one cannot equate the host-parasite interaction data acquired through studies in the Pacific Northwest and on Vancouver Island to this area.

Research Needs

The primary research needs are to evaluate the rates of spread and intensification of hemlock dwarf mistletoe in young stands. Some of this work is underway and should be extended to other areas of southeast Alaska. If rates of intensification are slower in southeast Alaska, as preliminary results suggest, it should be determined why the differences exist. Other suggested areas of investigation are to determine the distribution of hemlock dwarf mistletoe in Alaska and to relate its presence and abundance to ecological factors such as elevation, islands vs. mainland, topography, habitat types, latitude, etc.. Indications are that some partial cuttings will be made in old growth hemlock stands, and therefore data are needed on the behavior of the parasite on remaining trees in such stands so that effective guides for managing them can be developed.

Survey Needs

The need for information on the distribution of the pathogen is important to management planning if the effect of dwarf mistletoe is to be minimized in southeast Alaskan hemlock.

Greatest concern is with those areas that have been cutover recently where residuals, which may or may not be infected, are still present. Several of the areas visited contained so few residuals that, regardless of how severely they were infected, mistletoe spread from those few residuals would affect only a very small percentage of the new stand by the time it reached the projected rotation age (80-120 years). A survey system is needed to delineate those areas where the residuals are so few they are of little concern. More intensive surveys to determine the level of infection in residuals can then be concentrated in the remaining cutover stands. In other words, a means of stratification is needed which would allow the manager to concentrate on those stands that required a more intensive evaluation prior to some management activity.

Aerial sketchmapping techniques used by FI&DM entomologists in other Regions might be considered. In addition, oblique infrared and color photography could be used to evaluate recently cutover areas to determine the number of residuals remaining.

In addition to such a preliminary survey, biological evaluations should be carried out prior to any thinning operation in cutover areas. When mistletoe is present, a biological evaluation would delineate those areas where care must be taken to segregate mistletoe-infected trees during the thinning operation.

Distribution data are also needed for old growth stands for the overall planning and utilization process. Such data would help in locating cutting boundaries, and in setting priorities for future thinning and regeneration operations. Forest Survey and Timber Inventory files could provide incidence data for much of southeast Alaska now. By accessing present data it would be possible to acquire at least a minimum estimate of dwarf mistletoe incidence by plot, as well as an indication of the mortality and cull associated with the presence of this pathogen.

It is important that future insect and disease data collection be improved in the Forest Survey and Timber Inventory processes in R-10. An attempt is being made in all Regions and Areas to increase the quality of insect and disease data contained in the Survey and Inventory files.

RECOMMENDATIONS

Management Concerns

1. We strongly recommend that future harvesting contracts require all trees greater than two inches DBH (diameter at breast height) be cut during the harvesting operation. This will ensure that the probability of reinvasion by dwarf mistletoe will be extremely low.

2. Based on our limited observations and preliminary work by Dr. Shaw, we recommend that mistletoe control be combined with precommercial thinning when at all possible. The need for a dwarf mistletoe control project prior to that time does not appear to be necessary in most cases. If pre-commercial thinning is not being considered for a particular stand, and biological evaluation results suggest that the number of infected residuals and the potential for infection of the reproduction is extremely high, then residual removal for mistletoe control might be considered. It is our understanding that the marking procedures used in southeast Alaska generally result in increasing the proportion of spruce in the stand; this procedure would tend to reduce the effect of dwarf mistletoe in the new stand by reducing the proportion of susceptible host trees.

3. Biological evaluations should be conducted by qualified plant pathologists prior to any pre-commercial or commercial thinning operation.

4. It is also recommended that biological evaluations be conducted prior to the harvesting of old growth. This is to ensure that cutting boundaries go through non-infested areas whenever possible. Such evaluations help locate areas where special care should be taken to leave no residuals after harvesting operations are completed. Clearcuts should have an area:edge ratio as high as possible in those areas where mistletoe is present (a circular clearcut would give the highest area:edge ratio). This type of cutting pattern tends to reduce losses from blowdowns as well, as

leaving large fingers of trees or cutting large convoluted areas generally contributes to losses from blowdown in southeast Alaska.

Several forest managers inquired about mistletoe control in relation to clearcut size. Figure 2 (Dooling and Brown, 1976) was included to show this relationship. Note that above 40 acres, the proportion within 1/2-chain of the edge decreases very slowly. Circular or square clearcuts as small as 40 acres containing no residuals still would result in good mistletoe control since initial spread of the parasite would be limited to this zone.

5. Distribution data presently available through Forest Survey and Timber Inventory should be retrieved and verified from the data files for use in making management decisions. Other related information including site, aspect, age, etc. should be retrieved as well. (See Research Needs, Sections II A & B)

6. Any selection cutting done in hemlock stands should be done with great care, and should probably have input from Regional FI&DM personnel for assistance in marking such harvesting areas when mistletoe is known to be present.

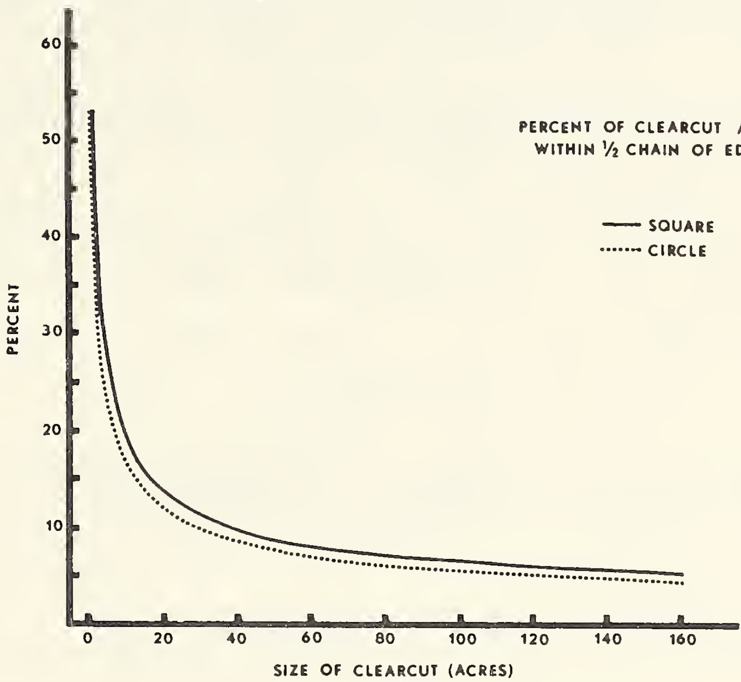

Figure 2. The percentage of a square or circular clearcut area within 1/2-chain of the edge of the clearcut relative to the size of the clearcut (Dooling and Brown 1976).

Research Needs

I. Higher Priority Studies (next 1-3 years).

A. Quantify the rates of spread and intensification of dwarf mistletoe in young stands adjacent to infected residual overstory trees or clearcut edges. Study PNW 1652:P1, initiated in 1977, should be continued to check applicability of results throughout southeast Alaska.

B. Inoculation studies to determine basic aspects of the life cycle of the hemlock dwarf mistletoe such as: percent infection for seeds placed on various host tissues; length of time from infection initial swellings; shoot production; and seed production. Study PNW 1652:P2, begun in 1977 in the Lemon Creek area north of Juneau, should be duplicated in a higher rainfall area (e.g., Ketchikan) for comparison with Juneau results.

C. Pollination: Studies should be made to determine the proportion of seed set in dwarf mistletoe plants located in clearcut areas in comparison with those in uncut stands. Companion studies should be made to determine the pollinating systems of hemlock dwarf mistletoe in southeast Alaska. For example, is pollination affectd by wind or insects? If the latter, which insects are involved? Is the pollinating system severely disrupted by clearcutting?

D. Seed dispersal: Studies using seed traps should be conducted to evaluate mistletoe seed production in isolated infected residual trees, in clearcuts, and in edges of clearcut boundaries.

II. Studies of Lower Priority (3-5 years).

A. Determine the distribution of hemlock dwarf mistletoe in southeast Alaska. This would involve synthesis of information from (1) Forest Survey records, (2) herbarium records, (3) personal records, and (4) specific surveys in areas where the status of dwarf mistletoe is unknown. An attempt should be made to correlate mistletoe occurrence and severity with site and topographic features, e.g., presence as related to island size, east vs. west side of island, site index, etc..

B. Some preliminary reports, and our observations, suggest that dwarf mistletoe occurrence is related to elevation. Laurent (unpublished data) has found mistletoe as high as 1200 feet but he finds that most is encountered below 800 feet. In our limited travels, we found most mistletoe below 500 feet, and the parasite seems to be more abundant approximately 200 feet above sea level. Also, most cutting has been concentrated in this lower elevational zone. It would be useful to assemble

all available elevation information from Forest Inventory, personal observations, and specific surveys to correlate dwarf mistletoe occurrence with elevation, and to determine how this is affected by latitude, aspect, and distribution on the various islands.

C. Since timber management practices in the future are expected to involve a limited amount of partial cutting in old growth stands, it is necessary to determine what responses can be anticipated in mistletoe infected hemlocks. Which infected trees should be removed in partial cuttings?

D. Although it is clear that the Alaska dwarf mistletoe is of serious concern only on western hemlock in Alaska, it is found rarely on Sitka spruce (Laurent 1966). Since the same mistletoe (or perhaps races of it) occur on shore pine, mountain hemlock, and Pacific silver fir in British Columbia, Oregon, Washington, and California, observations should be continued on these species when they occur in infested stands of western hemlock. The shore pine race of the parasite occurs in British Columbia as far north as Terrace (ca. 54° 30'N) on the mainland, and Point Clements on the Queen Charlotte Islands (Wass 1976), and could occur in southeast Alaska.

E. Dwarf mistletoe infection in hemlock boles seem to have a much greater impact on volume loss due to cull than for other dwarf mistletoes. The extent and types of cull associated with bole infections by the parasite should be evaluated.

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APPENDIX I

List of Participants

Dr. C. G. Shaw, Forest Pathologist with the Forestry Sciences Laboratory, Juneau, and Tom Laurent, Forest Pathologist, FI&DM, R-10, Juneau, accompanied us in the field. In addition, Al Harris, Silviculturist with the Forestry Science Laboratory, joined us from May 21 through 25.

The following people were consulted or assisted us:

Ketchikan Area - May 21-23.

Jim Watson, Area Supervisor
Rick Hauver, Silviculturist
John Peeler, Forester, Metlakatla Village Corp.
Jim Lincoln, Resource Management Assistant
Fred Ziegler, Resource Management Assistant

Petersburg Area - May 24-25

John Butruille, Area Supervisor
Dennis Murphy, Silviculturist
Spencer Israelson, Technician

Chatham (Sitka) Area - May 30

John Standerwick, Timber Management Officer
Bob Smith, Silviculturist
Harry Gibson, Resource Management Assistant
Stan Johnson, Technician

Juneau, Regional Office - May 31-June 1

John Sandor, Regional Forester
Duane Packer, Timber Management
Bob Averill, FI&DM (Anchorage)

Juneau, Forestry Sciences Laboratory - May 28-31

Don Schmiege, Project Leader

FI&DM/Methods Application Group, Davis, CA

Bill Ciesla, Group Leader

APPENDIX II

Itinerary

May 21, Ketchikan Area

Hemlock Island, Metlakatla Indian land, south of Ketchikan: Examined a 60-70-year-old hemlock stand with many infected residuals.

Three Island Point, on Cleveland Peninsula: Examined a heavily infected and strongly stagnated hemlock pole stand. Stagnation is very rare in hemlock in southeast Alaska. Scattered residuals were also heavily infected.

May 22-23, Prince of Wales Island

Thorne Bay: Examined Sitka spruce stand at Narrow Point with numerous burls of unknown cause. Cause may be the same as those on white spruce along the coast of Maine. Examined potential study areas of mistletoe spread from infected residuals to a 13-year-old stand. No infection was found in the young stand.

Thorne River: Examined a 60-year-old hemlock-spruce stand that developed following logging of airplane spruce in World War II. Excellent site (site index 125) with very little obvious effect of mistletoe.

Shaheen Dump: Examined 40-year-old hemlock-spruce stand with scattered old infected residual hemlocks. The trees in the 40-yuear-old stands were generally lightly infected (DMR 2 or 3). These trees have few infections and thre is no apparent effect of mistletoe on growth or form.

Stanley Creek, Twelve Miles areas: Several hundred acres of clearcuts, 5-15 years old, were examined. Infected residuals were variable, from one or two per acre to 100 or more, but no infection was found in the young stands.

Maybeso Experimental Forest, Hollis: Thinning in a 22-year-old spruce-hemlock stand was observed. Four levels of thinning were being tested: no thinning (ca. 5000 trees per acre); thinning to 8 x 8 feet; 12 x 12 feet; and 16 x 16 feet. To date, growth on trees thinned to 16 x 16 feet has been the best. No mistletoe was observed in these stands, as all residuals were removed soon after logging.

Hollis: Several clearcuts up to 20 years old were examined, but were either not infected, or only slightly so, even near heavily infected residuals.

May 24-25, Petersburg Area

Loop Road, south of Petersburg: Most clearcuts have been cleared of residual trees, and little infection was seen in young stands. Old growth stands, particularly below 300 feet in elevation, were heavily infected, but a 180-yeard-old, even-aged stand had only occasional pockets of heavy infection.

Kake-Hamilton Bay Area, Kupreanof Island: Several clearcuts, 10-12 years old, were examined, but no infection was found in young trees, even near heavily infected residuals. Mountain hemlocks adjacent to infected western hemlocks in uncut stands were not infected. Collections of pistillate mistletoe plants in an isolated residual hemlock showed no seed set, suggesting that the plant had not been pollinated. However, trees in groups contained mistletoe plants that were successfully pollinated.

May 29, Juneau Area

Juneau to Eagle River: Mistletoe was common and damaging in old growth stands, with very limited spread to adjacent young trees.

We visited Dr. Shaw's mistletoe inoculation plots in a young stand on Lemon Creek. Approximately 800 seeds were planted in both 1977 and 1978. The 1978 seeds had just started to germinate; many seeds from the 1977 inoculation had apparently formed holdfasts but no swellings were seen in the few inoculations examined. The angle of each needle on which a seed was placed was recorded to see how this related to seed movement and subsequent infection.

May 29, Young Bay, Admiralty Island

Examined an old growth hemlock-spruce stand on the Young Bay Experimental Forest. The stand contained several old growth trees that were apparently killed by mistletoe. It appeared that mistletoe develops very slowly in these old growth stands.

May 30, Chatham (Sitka) Area

Kidney Bay, Redoubt Bay: We examined stands recently cutover and some logged up to five years previously. Very heavy infection and mortality were observed in old growth stands (the most severe encountered on our trip). Young stands were fairly clear of residuals so no mistletoe reinvasion is expected except along edges of clearcuts.

May 31, Haines Area

We examined hemlock-spruce stands south and north of Haines. Dwarf mistletoe plants were unusually abundant and vigorous in uncut stands. Very little infection was developing in a 10-20 year reproduction. Dwarf mistletoe at Chilkoot Lake (about 10 miles north of Haines) is of

interest, as this is the northernmost known location for hemlock dwarf mistletoe (approximaately 59° 20' North latitude).

May 31-June 1, Juneau

Discussed impressions from our trip with Regional Forester John Sandor; Forestry Sciences Laboratory Project Leader Don Schmiege; FI&DM Staff Director Bob Averill, Anchorage; FI&DM/MAG Group Leader Bill Ciesla; and Acting Staff Director Duane Packer, Timber Management, R-10.